FAUNAL DIVERSITY OF ROTIFERS (ROTIFERA: EUROTATORIA) OF DEEPOR BEEL, ASSAM (NORTHEAST INDIA) – A RAMSAR SITE[1]

B.K. Sharma[2] and Sumita Sharma[3]

[1]Accepted April 2004
[2]Department of Zoology, North-Eastern Hill University, Umshing, Shillong 793 022, Meghalaya, India.
Email: bksharma@nehu.ac.in, profbksharma@hotmail.com
[3]Eastern Regional Station, Zoological Survey of India, Risa Colony, Shillong 793 003, Meghalaya, India.
Email: sumitazsi@hotmail.com

This pioneering taxonomic study on Rotifera of Ramsar sites of India deals with the analysis of plankton samples collected (from November, 2002 to October, 2003) from Deepor beel, a tropical floodplain lake of the Brahmaputra river basin of lower Assam (NE India). One hundred and ten species belonging to 35 genera and 20 families, documented in this study register the highest biodiversity of this phylum known till date from any aquatic ecosystem of the Indian subcontinent and reflects greater environmental heterogeneity of the sampled Ramsar site. The rotifer communities are characterized by Cosmopolitan (67.3%) > Pantropical (17.3%) > Cosmotropical (10.0%) elements, predominance of Lecanidae > Brachionidae > Lepadellidae > Trichocercidae, general tropical characters and several biogeographically interesting elements and acidophilus species. Species richness (43-65; 56 ±6 species) depicts trimodal monthly pattern with peak and minima during winter and early summer respectively, and shows 45.1-82.5% community similarity (*vide* Sorenson's index). The richness registers significant inverse correlation with water temperature, rainfall, free CO_2 and Calcium, and direct relationship with specific conductivity, dissolved oxygen and BOD_5. Our observations indicate lack of definite periodicity of occurrence of different species or families or groups of rotifers and record fewer perennial species. The examined collections show dominance of littoral or periphytic elements, fewer planktonic species and relatively higher number of small-sized taxa. Sladecek's $Q_{B/T}$ quotient depicts mesotrophic-eutrophic nature of Deepor beel.

Key words: Ramsar site, Rotifera, biodiversity, distribution, temporal variations

INTRODUCTION

Floodplain lakes (locally known beels) attract special global interest for their rich aquatic biodiversity and great biogenic production potential. These interesting ecotones comprise an integral component of the valley districts of Assam and Manipur of northeast India. Beels cover an area of 0.1 million ha of Assam, and constitute about 93% of its total fish-prone (i.e. area under fisheries) and play vital role in the socio-economic development of the region. Of these, Deepor beel, one of the largest wetland in the Brahmaputra valley of lower Assam, is under severe environmental pressure because of human encroachment and general degradation. This water body of great economic importance has been designated as a Ramsar site in November 2002, and attempts are being initiated for its biodiversity conservation. Very little is known about the micro-faunal diversity of this ecosystem (www.wwfindia.org) and information on rotifers is still lacking. This pioneering taxonomic study on the Rotifera of Ramsar sites of India assumes significance in view of limited works on biodiversity of this phylum (Sharma and Sharma 2001) from the floodplain lakes of India, in general, and that of the Northeast region in particular. The observations are made on species composition of the rotifer taxocoenosis of Deepor beel with remarks on its general nature and composition, species richness, temporal variations, community similarities, interesting elements and on trophic status of the wetland based on the rotifer taxa (*vide* Sladecek's quotient).

MATERIAL AND METHODS

The present study is a part of limnological survey, undertaken during November 2002 to October 2003, in Deepor beel, a perennial floodplain lake (26° 03' 26" N and 90° 36' 39" E; area: 40 km^2; altitude: 42 m above msl) located in the Kamrup district of lower Assam. This beel is covered with luxuriant growth of diverse aquatic macrophytes, namely *Hydrilla verticillata*, *Naias indica*, *Euryale ferox*, *Vallisnaria spiralis*, *Utricularia flexuosa*, *Trapa bispinosa*, *Eichhornia crassipes*, *Monochoria hastaefolia*, *Xanthium straumarium*, *Ipomea fistulosa*, *Croton borplandianum*, *Hydrorhiza aristata*, *Polygonum hydropiper* and *Limnophila* sp. Water samples, collected monthly, were analyzed for various abiotic factors following APHA (1992) while water temperature, specific conductivity, pH, transparency and dissolved oxygen were recorded by field probes. Qualitative plankton samples were obtained regularly every month by towing nylobolt plankton net (No. 25) from different parts of the beel and preserved in 5% formalin. These samples were subsequently screened for various rotifer species and their permanent mounts were made

in polyvinyl alcohol-lactophenol mixture. The rotifer taxa were identified following Kutikova (1970), Koste (1978), Koste and Shiel (1990), Segers (1995) and Sharma and Sharma (1999, 2000). In addition, Segers (2002) was followed for the recent nomenclature of Rotifera. Percentage similarities between monthly rotifer communities were calculated *vide* Sorensen index. Ecological relationships were computed *vide* simple correlation coefficients (r). $Q_{B/T}$ quotient (Sladecek 1983) has been used to comment on the general trophic status of the wetland.

RESULTS AND DISCUSSION

Deepor beel is characterized (Table 1) by low ionic concentration which warrants its inclusion under 'Class I' category *vide* Talling and Talling (1965). Mean water temperature affirms tropical range related to its geographical location. Circum-neutral and marginally hard waters of this floodplain lake depict moderate dissolved oxygen, low free CO_2, low concentration of micro-nutrients and other abiotic factors. Chloride and BOD_5 reflect some possible impact of human activity on this Ramsar site. The ranges of the recorded abiotic factors agree with earlier reports of Sharma and Hussain (1999), Sharma (2000a, b) and Sharma and Sharma (2001).

The present study reveals the highest diversity of Eurotatoria (110 species, 35 genera and 20 families) known till date from any aquatic environ of the Indian subcontinent

Table 1: Abiotic factors of Deepor beel

Factors	Mean ± SD
Rainfall (mm)	195.4 ± 158.2
Water temperature (°C)	27.4 ± 4.6
pH	7.03 ± 0.2
Transparency (cm)	56.9 ± 24.0
Specific Conductivity (µS/cm)	103.8 ± 14.6
Dissolved oxygen (mg/l)	6.4 ± 1.9
Free CO_2 (mg/l)	6.2 ± 2.2
Alkalinity (mg/l)	68.6 ± 10.6
Hardness (mg/l)	63.5 ± 10.5
Calcium (mg/l)	19.7± 1.8
Magnesium (mg/l)	3.9 ± 0.5
Chloride (mg/l)	24.7 ± 4.4
Dissolved Organic Matter (mg/l)	2.33 ± 0.37
Total dissolved Solids (mg/l)	1.69 ± 0.46
Phosphate (mg/l)	0.14 ± 0.04
Sulphate (mg/l)	9.0 ± 2.7
Nitrate (mg/l)	0.65 ± 0.17
Silicate (mg/l)	2.78 ± 0.71
B.O. D_5 (mg/l)	2.23 ± 0.63
Sodium (mg/l)	13.4 ± 1.9
Potassium (mg/l)	4.46 ± 0.75

(Table 2). The rich and diversified rotifer taxocoenosis is undoubtedly an indicator of greater environmental heterogeneity of the Deepor beel and thus concurs with generalizations of José de Paggi (1993), Bonecker *et al.* (1998) and Shiel *et al.* (1998) on floodplain lakes of Argentina, Brazil and Australia respectively. Besides, this salient feature lends significant support to the hypothesis of Segers *et al.* (1993) indicating (sub) tropical floodplains to be the world's richest habitats for rotifers. The documented species comprise notable fraction (30.9%) of the Indian Rotifera and the fauna of NE India (57.6 %). Overall, rotifer richness of this Ramsar site compares well with 111 species from floodplains of Argentina (José de Paggi 1993); is marginally higher than the 104 species from Laguana Bufeos, Bolivia (Segers *et al.* 1998) and is lower than the reported 136 species (Iyi-Efi lake) and 124 species (Oguta lake) in the Niger delta (Segers *et al.* 1993), and 130 species from Lake Guarana, Brazil (Bonecker *et al.* 1994).

Referring to the Indian conditions, the rotifer diversity of Deepor beel presents a significant increase in the peak value of 65 species recorded by Sharma and Sharma (2001) from Dighali beel, Assam and exceeds the recent highest record of 103 species again from Dighali beel (Sharma 2005). The richness is distinctly higher than the reports of only 29 species from four beels (Goswami 1997), 48 species from 33 beels (Sarma 2000), 54 species from five beels (Sharma 2000b) and 9 species from Mori beel (Goswami and Goswami 2001) of Assam state. It is also significantly higher than 11 species from two floodplain lakes of Kashmir (Khan 1987) as well as of 37 species from two Ox-bow lakes (Khan 2002), and 38 species from 9 floodplain lakes (Khan 2003) of South-eastern West Bengal. The poor records in several Indian works are in fact not due to actual paucity of rotifers in the floodplain lakes, but due to inadequate sampling, overlooking identification of smaller taxa and incomplete analysis due to lack of taxonomic expertise (BKS *pers. comm.*). Interestingly, the rotifer richness of this floodplain lake of the Brahmaputra river basin corresponds to the 110 species from the backwaters of the river Yamuna at Delhi (Arora and Mehra 2003). This study, however, shows only 50% community similarity with the latter, and hence shows significant divergence in the communities of two environs.

Lecanidae (30 species) > Brachionidae (19 species) > Lepadellidae (15 species) > Trichocercidae (7 species) constitute a dominant fraction (64.6%) of Rotifera of Deepor beel and of their monthly composition (54.5-69.8%, 60.1±4.2%). The stated dominance trend corresponds with the reports from floodplains of South America (Bonecker *et al.* 1994, 1998; Lansac-Tôha *et al.* 1997; Rossa 1997; Serafim 1997), Argentina (José de Paggi 1993, 2001), Africa (Segers *et al.* 1993), Bolivia (Segers *et al.* 1998), Thailand (Sanoamuang 1998) and India

Table 2: Rotifer Taxocoenosis of Deepor Beel

Reported taxa	Months
Family: **Brachionidae**	
Anuraeopsis fissa (Gosse)	N, F, M, JL-O
Brachionus angularis Gosse	N-AP, JL-O
B. bidentatus Anderson	N-MA, M, JL, O
B. calyciflorus Pallas	D-MA, JL, A, O
B. caudatus Barrois & Daday	N-O
B. diversicornis (Daday)	D-AP, J, S
B. donneri Brehm	AP, J
B. falcatus Zacharias	N-O
B. forficula Wierzejski	N-M, JL-S
B. mirabilis Daday	JN, J-A, O
B. quadridentatus (Hermann)	N-O
B. rubens Ehrenberg	AP-J
Keratella cochlearis Gosse	N-O
K. tropica (Apstein)	N-O
K. lenzi Hauer	N-F, M-O
K. procurva (Thorpe)	JN, AP-A
K. quadrata (Müller)	N-D, F-MA, J, A, O
Platyias quadricornis (Ehrenberg)	N-O
Plationus patulus (Müller)	N-O
P. patulus macracanthus (Daday)	N-O
Family: **Epiphanidae**	
Epiphanes brachionus (Ehrb.)	D, JL, A, S
Family: **Euchlanidae**	
Euchlanis dilatata Ehrenberg	N-O
E. incisa Carlin	D-JN
E. triquetra Ehrenberg	N, M
Dipleuchlanis propatula (Gosse)	N, D, F, M, JL, A, O
Beauchampiella eudactylotum (Gosse)	JN, J
Family: **Mytilinidae**	
Mytilina bisulcata (Lucks)	N-JN, M, J, O
M. ventralis (Ehrenberg)	N-F, M, J, A, S
Family: **Trichotriidae**	
Macrochaetus sericus (Thorpe)	N-MA, M-S
Trichotria tetractis (Ehrenberg)	N-F, M-S
Family: **Lepadellidae**	
Colurella obtusa (Gosse)	N, JN -MA, M, S
C. uncinata (Müller)	D-JN, MA-AP, JL, S
Lepadella acuminata (Ehrenberg)	N, MA, J
L. aspicora (Myers)	JN, O
L. apsida Harring	D-JN, A
L. biloba Hauer	S
L. discoidea Segers	A
L ehrenbergi (Perty)	N, F-MA, M, O
L. heterostyla (Murray)	N, JN, MA, A, O
L. minuta (Montet)	D, AP
L. ovalis (Müller)	D-MA, J-A, O
L. patella (Müller)	N, F-MA, JL, S, O
L. rhomboides (Gosse)	N, JN-M, JL-S
L. triptera Ehrenberg	D, AP
Squatinella mutica (Ehrenberg)	N, MA, M-A, O

Reported taxa	Months
Family: **Lecanidae**	
Lecane aculeata (Jakubski)	N, JN-MA, M, JL, S
L. bulla Gosse)	N-O
L. closterocerca (Schmarda)	D, F, M-O
L. crepida Harring	D, AP, J
L. curvicornis (Murray)	N-MA, M, J, A-O
L. decipiens (Murray)	JN, M, S-O
L. furcata (Murray)	AP, JL
L. hamata (Stokes)	N-F, M, S
L. hastata Murray	JL
L. hornemanni (Ehrenberg)	N, F, M, A
L. inermis (Bryce)	N, MA, AP
L inopinata Harring & Myers	M, JL, S
L. leontina (Turner)	N-O
L. ludwigii (Eckstein)	A
L. luna (Müller)	D, F-MA, J,A,O
L. lunaris (Ehrenberg)	D-F, A-S
L. monostyla (Daday)	N, AP
L. nana (Murray)	AP, J, S
L. obtusa (Murray)	O
L. ohioensis (Herrick)	AP, M, JL, A, O
L. papuana (Murray)	D-JN, MA, J-S
L. ploenensis (Voigt)	N, JN-F, J, A, O
L. pertica Harring & Myers	N-D, O
L. pyriformis (Daday)	JN, AP, JL, S-O
L. quadridentata (Ehrenberg)	N-F, M, A-O
L. sola Hauer	MA, AP
L. stenroosi (Meissner)	N, MA
L. thienemanni (Hauer)	F-MA, J-A
L. unguitata (Fadeev)	N-JN, AP, M, JL-S
L. ungulata (Gosse)	N-O
Family: **Notommatidae**	
Cephalodella forficula (Ehrenberg)	JN, F, MA,JL-S
C. gibba (Ehrenberg)	D, F, AP
C. mucronata (Harring & Myers)	O
Monommata longiseta (Müller)	N-F, MA, A-O
Family: **Scaridiidae**	
Scaridium longicaudum (Müller)	D-MA, M-J, S
Family: **Trichocercidae**	
Trichocerca cylindrica (Imhof)	N, D, F, J, A, O
T. capucina (Wier. & Zach.)	N, JN, F, MA, J, A, O
T. elongata (Schrank)	N-F, AP, A, S
T. longiseta (Schrank)	N-F, J, A, S
T. porcellus (Gosse)	N, JN-MA, JL, A, O
T. rattus (Müller)	D, MA, AP
T. similis (Wierzejski)	N, J, F, MA, JL,S
Family: **Asplanchnidae**	
Asplanchna priodonta Gosse	N-O
Family: **Synchaetidae**	
Polyarthra vulgaris Carlin	N-O

Table 2: Rotifer Taxocoenosis of Deepor Beel (*contd.*)

Reported taxa	Months	Reported taxa	Months
Family: Dicranophoridae		*F. longiseta* (Ehrenberg)	N, J-F, MA, J-S
Dicranophorus forcipatus (Müller)	D-F, M, J, A, S	*F. opoliensis* (Zacharias)	N-MA, J, S
		F. pejleri (Hutchinson)	D, F, M, M-JL, S, O
Family: Flosculariidae			
Floscularia ringens (Linnaeus)	A	**Family: Testudinellidae**	
Lacinularia flocculosa (Müller)	S	*Testudinella brevicaudata* Yamamoto	A, S
Limnias ceratophylli Schrank	O	*T. emarginula* (Stenroos)	JN-MA, O
Sinantherina spinosa (Thorpe)	N-O	*T. greeni* Koste	D, JL
S. socialis (Linnaeus)	MA-A	*T. patina* (Hermann)	N-O
		Pompholyx sulcata Hudson	MA
Family: Conochilidae			
Conochilus unicornis Rousselet	N-O	**Family: Trochosphaeridae**	
		Trochosphaera aequitorialis Semper	D-J, MA-A, O
Family: Hexarthridae			
Hexarthra mira (Hudson)	JN, J, O	**Family: Philodinidae**	
		Rotaria rotatoria (Ehrenberg)	N
Family : Filiniidae		*R. neptunia* (Ehrenberg)	N, MA, M, S
Filinia brachiata (Rousselet)	O	*Philodina* sp.	N
F. camascela Myers	D-S		

Abbreviations (months): N-November, D-December, JN-January, F-February, MA-March, AP-April, M-May, J-June, JL-July, A-August, S-September, O-October

(Sharma and Sharma 2001). This trend also confirms with the composition of the Indian Rotifera (Sharma 1998). In addition, Euchlanidae = Filiniidae = Testudinellidae = Flosculariidae > Notommatidae comprise an important component (22.7%). Qualitative significance (37.3%) of 'tropic-centered' genera namely *Lecane* (30 species) and *Brachionus* (11 species) imparts tropical character to the rotifer fauna of Deepor beel affirming such generalizations on other tropical faunas (Fernando 1980; Dussart *et al.* 1984; Segers 1996). This conclusion is, in turn, supported by paucity of 'temperate-centered' *Keratella* (5 species). *Lecane* spp. alone comprise a notable fraction (27.3%) and their dominance compares with the rotifer communities of other floodplains (Segers *et al.* 1993, 1998; Sanoamuang 1998; Josè de Paggi 2001).

The predominance of cosmopolitan species (67.3%), another salient feature of this study, concurs with the results of Sharma and Sharma (2001). Besides, pantropical > cosmotropical species together form notable component (27.3%). The examined material includes four interesting palaeotropical elements, namely *Testudinella greeni*, *T. brevicaudata*, *Lecane unguitata* and *Lepadella discoidea*. The first two species are so far recorded only from the floodplains of NE region while the lecanid is apparently widely distributed in India. *L. discoidea* is known from Indonesia, Australia, Zaire, Nigeria and Papua New Guinea while its Indian reports are from Delhi and the northeastern state of Assam. Segers (1993) proposed possible inclusion of the new taxon *Lepadella ovalis* f. *larga* described by Sharma (1978) from West Bengal under the former species. The specimens from West Bengal are larger than Segers' species (*L. discoidea*) and more material is required to ascertain correct status of the Indian taxon. Other biogeographically important elements recorded presently are the pantropical *Brachionus donneri*, *Lecane pertica*, *L. hastata*, *L. thienemanni*, *Filinia camascela* and *Trochosphaera aequitorialis*. In addition, the colonial *Sinantherina spinosa*, the sessile *Floscularia ringens*, *Lacinularia flocculosa* and *Limnias ceratophylli* as well as cosmopolitan *Lepadella biloba*, *L. minuta* and *Lecane sola* are examples of regional distributional interest. Among these, *B. donneri* and *L. sola* deserve special mention as species originally described from this country. A majority of the stated species are rare in our material and also represent rare elements in the Indian fauna.

Qualitative abundance of periphytic or littoral elements (76.2%) and occurrence of fewer planktonic species (23.8%) indicate lack of definite pelagic habitats (De Manuel 1994) which, in turn, can be attributed to shallow nature of Deepor beel as well as the presence of aquatic macrophytes. Our observations exhibit frequent occurrence of non-planktonic taxa in open waters of the sampled lake; this feature of establishment of both planktonic and non-planktonic taxa in beel with marginal vegetation suggests occupation of different niches (Bonecker *et al.* 1998). Besides, the present study indicates occurrence of a number of small-sized rotifer

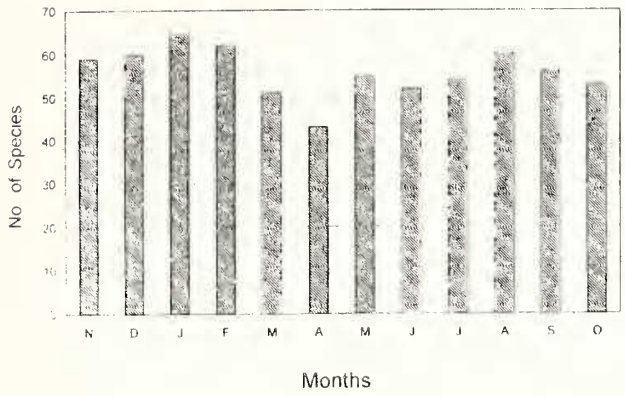

Fig 1: Species richness of Rotifera

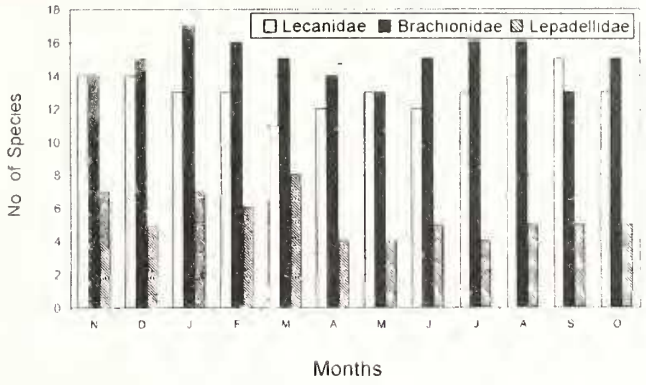

Fig 2: Species richness of dominant families

taxa, which may be attributed to conditions of low concentrations of food (Papinski 1990) and predation by fish and invertebrates (Baumgartner *et al.* 1997). The former aspect is supported by lower phytoplankton density and primary productivity of Deepor beel (Sharma unpublished).

Acidophilus elements (Koste 1978) reported presently include *Plationus patulus macracanthus*, *Dipleuchlanis propatula*, *Euchlanis triquetra*, *Mytilina bisulcata*, *Lepadella acuminata*, *Lecane pertica*, *Monommata longiseta* and *Testudinella emarginula*. The relative paucity of *Brachionus* (11 species) in general is attributed to acidic-circum neutral nature of the sampled beel. Only sixteen rotifers (14.5 %) namely *Brachionus caudatus*, *B. falcatus*, *Plationus patulus*, *P. patulus macracanthus*, *Platyias quadricornis*, *Keratella cochlearis*, *K. tropica*, *Euchlanis dilatata*, *Lecane bulla*, *L. leontina*, *L. unguitata*, *Asplanchna priodonta*, *Polyarthra vulgaris*, *Sinantherina socialis*, *Conochilus unicornis* and *Testudinella patina* represent perennial elements. Twenty eight species (25.4%) i.e., *Brachionus angularis*, *B. bidentatus*, *B. falcatus*, *B. forficula*, *B. quadridentatus*, *Anuraeopsis fissa*, *Keratella cochlearis*, *K. tropica*, *Plationus patulus*, *Euchlanis dilatata*, *Mytilina ventralis*, *Trichotria tetractis*, *Lepadella ovalis*, *L. rhomboides*, *Lecane bulla*, *L curvicornis*, *L. luna*, *L. leontina*, *L. papuana*, *L. ungulata*, *L. lunaris*, *Polyarthra vulgaris*, *Testudinella patina*, *Trichocerca porcellus*, *T. similis*, *Filinia longiseta*, *F. opoliensis* and *F. camascela* exhibit common occurrence while *Brachionus mirabilis*, *Mytilina bisulcata*, *Lepadella apsida*, *L. minuta*, *L. discoidea*, *Lecane hastata*, *L. monostyla*, *L. furcata*, *L. sola*, *Filinia brachiata*, *Testudinella brevicaudata* and *T. greeni* are rare elements.

The present observations depict qualitative predominance of rotifers in Deepor beel throughout the study period and this trend concurs with the results of Sarma (2000), Sharma (2000a, b), Sharma and Sharma (2001) and Khan (2002). The richness (43-65; 56 ±6 species) shows a trimodal pattern of temporal variations (Fig. 1) with peak during January (winter) and minima in April (early summer). In general, higher richness (60-65 species) noticed during winter (December-February) is supported by significant inverse correlation with water temperature (r = -0.764) while it also records inverse relationship with rainfall (r = -0.516), free CO_2 (r = -0.469) and Calcium (r = -0.442). Species richness, however, registers significant direct correlation with specific conductivity (r = 0.534), dissolved oxygen (r = 0.469) and BOD_5 (r = 0.474). Three eurotatorien families namely Brachionidae (13-17; 15 ±1 species) > Lecanidae (11-15; 13 ±1 species) > Lepadellidae (4-8; 5 ±1 species) mainly influence (Fig. 2) temporal variations of rotifer diversity, but do not follow any definite seasonal or monthly trend. The later generalization also holds true for occurrence of different species. The communities similarity (45.1- 82.5%) depicts distinct variations in species composition. Peak similarity is noted between the samples collected in February and July, while April registers lowest similarity (45.1-59.6%) with other monthly samples. Further, the matrix indicates (Table 3) fewer cases of < 50% and > 80% similarity, which ranges between 60-70% in majority (48.6%) of instances.

Sladecek (1983) proposed $Q_{B/T}$ quotient based on ratios between *Brachionus* : *Trichocerca* species to depict trophic status of different ecosystems or even individual samples. The utility of application of this quotient under Indian conditions is ascertained by Sharma and Dudani (1992) and Sharma (2000a). The present results indicate $Q_{B/T} = 2.4$ and, thereby, reflect general mesotrophic status of Deepor beel while its monthly values ranging between 1.4-4.5 indicate mesotrophic nature with shift towards eutrophy in certain months. This generalization is broadly affirmed by water quality of the wetland and temporal variations of various parameters during the study period.

To conclude, this study provides an exhaustive

Table 3: Percentage similarities (Sorenson's index) between Rotifer communities

Months	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
November	-	62.2	66.1	76.0	63.6	45.1	66.7	54.0	58.4	63.9	64.3	64.3
December		-	73.6	70.5	57.6	48.5	60.9	66.1	61.4	70.0	68.9	65.5
January			-	77.2	67.2	51.8	71.7	68.4	68.9	73.6	77.7	62.0
February				-	72.6	47.6	73.5	82.4	67.2	75.4	74.6	66.1
March					-	59.6	58.5	62.1	64.8	59.5	63.6	55.5
April						-	51.0	50.5	51.5	52.4	52.5	45.5
May							-	61.7	73.4	66.0	68.5	57.4
June								-	60.4	69.6	61.1	60.9
July									-	73.7	67.3	61.7
August										-	67.3	63.6
September											-	46.3
October												-

inventory of the rotifer taxa of the sampled Ramsar site and exhibits rich and diversified nature of the examined taxocoenosis. The rotifer communities are predominated by the monogonont taxa. Planktonic and littoral species are well documented in this study while epiphytic, benthic and bdelloids still need specific attention. The observations on the rotifer communities in relation to diverse aquatic macrophytes in this ecotone will be of special future interest to analyse species associations and horizontal distributional patterns.

ACKNOWLEDGEMENTS

The senior author is thankful to the G.B. Pant Institute of Himalayan Environmental Development, Almora for research grant for the study and the Head, Department of Zoology, North-Eastern Hill University, Shillong for laboratory facilities. One of the authors (SS) is also thankful to the Director, Zoological Survey of India, Kolkata and the Officer-in-charge, Eastern Regional Station, Zoological Survey of India, Shillong.

REFERENCES

APHA (1992): Standard Methods for the Examination of Water and Waste Water. American Water Works Association and Water Pollution Control Federation, 18th edn. New York, 1198 pp.

Arora, J. & N.K. Mehra (2003): Species diversity of planktonic and epiphytic rotifers in the backwaters of the Delhi segment of the Yamuna River, with remarks on new records from India. *Zool. Stud. 42(2)*: 239-247.

Baumgartner, G., K. Nakatani, K. Cavicchioli & M.S.T. Baumgartner (1997): Some aspects of the ecology of fish larvae in the floodplain of the high Parana river, Brazil. *Rev. Brasil. Zool. 14*: 551-563.

Bonecker, C.C., F.A. Lansac-Tôha & A. Staub (1994): Qualitative study of Rotifers in different environments of the high Parana river floodplain (Ms), Brazil. *Revista UNIMAR 16*: 1-16.

Bonecker, C.C., F.A. Lansac-Tôha & D.C. Rossa (1998): Planktonic and non-planktonic rotifers in two environments of the upper Parana river floodplain, state of Mato Grosso do Sul, Brazil. *Brazil. Arch. Biol. & Technology 41*: 447-456.

De Manuel, J. (1994): Taxonomic and zoogeographic considerations on Lecanidae (Rotifera: Monogononta) of the Balearic archipelago, with description of a new species, *Lecane margalefi* n. sp. *Hydrobiologia 288*: 97-105.

Dussart, B.H., C.H. Fernando, J. Matsmura-Tundisi & R.J. Shiel (1984): A review of systematics, distribution and ecology of tropical freshwater zooplankton. *Hydrobiologia 113*: 77-91.

Fernando, C.H. (1980): The freshwater zooplankton of Sri Lanka, with a discussion of tropical freshwater zooplankton composition. *Int. Rev. ges. Hydrobiol. 65*: 411-426.

Goswami, N. (1997): Studies on the productivity indicators in three different types of wetlands of Assam, India. Ph.D. thesis, Gauhati University, Assam.

Goswami, M.M. & N. Goswami (2001): Studies on productivity indicators in Mori beel of Assam. *Trop. Zool. 2 & 3*: 1-9.

José De Paggi, S. (1993): Composition and seasonality of planktonic rotifers in limnetic and littoral region of a floodplain lake (Parana River System). *Rev. Hydrobiol. trop. 26*: 53-64.

José De Paggi, S. (2001): Diversity of Rotifera (Monogononta) in wetlands of Rio Pilcomayo National Park, Ramsar site (Formosa, Argentina). *Hydrobiologia 462*: 25-34.

Khan, M.A. (1987): Observations on Zooplankton composition, abundance and periodicity in two flood-plain lakes of the Kashmir Himalayan valley. *Acta hydrochem. Hydrobiol. 15*: 167-174.

Khan, R.A. (2002): The ecology and faunal diversity of two floodplain Ox-bow lakes of South-Eastern West Bengal. *Rec. zool. Surv. India, Occ. Paper No. 195*: 1-57.

Khan, R.A. (2003): Faunal diversity of zooplankton in freshwater wetlands of Southeastern West Bengal. *Rec. zool. Surv. India, Occ. Paper No. 204*: 1-107.

Koste, W. (1978): Rotatoria. Die Rädertiere Mitteleuropas, begründet von Max Voigt. Überordnung Monogononta. Gebrüder Borntraeger, Berlin, Stuttgart. I. Text. (673 pp) U. II. Tafelbd. (T. 234).

Koste, W. & R.J. Shiel (1990): Rotifera from Australian inland waters V. Lecanidae (Rotifera: Monogononta). *Trans. R. Soc. S. Aust. 114(1)*: 1-36.

Kutikova, L.A. (1970): The rotifer fauna of the USSR. *Fauna SSSR 104*, Academia Nauk, 744 pp (in Russian).

Lansac-Tôha, F.A., C.C. Bonecker, L.F.M. Velho & A.F. Lima (1997): Comunidade zooplanctônica. Pp. 117-155. *In*: A Planície de Inundacâo do Alto Rio Paraná (Eds.: Vazzoler, A.E., A.A. Agostinho & N.S. Hahn), Editora da Universidade Estadual de Maringná, Maringná.

PAPINSKI, K. (1990): Abundance and composition of rotifers in the Vistula river. *Pol. Arch. Hydrobiol. 37*: 449-459.

ROSSA, D.C. (1997): Cosmpoicão e abundância do zooplâcton da região de uma lagoa de várzea e um rio da planície de inundacão do alto rio Paraná- MS. Monograph, State University of Maringná, Maringná. Paraná.

SARMA, P.K. (2000): Systematics, distribution and ecology of zooplankton of some floodplain wetlands of Assam, India. Ph.D. thesis, Gauhati University, Assam.

SANOAMUANG, L. (1998): Rotifera of some freshwater habitats in the floodplains of the River Nan, northern Thailand. *Hydrobiologia 387 / 388*: 27-33.

SEGERS, H. (1993): Rotifera of some lakes in the floodplain of the river Niger (Imo State, Nigeria). I. New species and other taxonomic considerations. *Hydrobiologia 250*: 39-61.

SEGERS, H. (1995): Rotifera 2: Lecanidae. *In*: Guides to identification of the Micro-invertebrates of the Continental waters of the world. *6*:1-226. (Eds. H.J. Dumont & T. Nogrady). SPB Academic Publishing bv. Amsterdam, The Netherlands.

SEGERS, H. (1996): The biogeography of littoral *Lecane* Rotifera. *Hydrobiologia 323*: 169-197.

SEGERS, H. (2002): The nomenclature of the Rotifera: annotated checklist of valid family- and genus-group names. *J. nat. Hist. Lond. 36*: 621-640.

SEGERS, H., N.L. FERRUFINO & L. DE MEESTER (1998): Diversity and Zoogeography of Rotifera (Monogononta) in a flood plain lake of the Ichilo river, Bolivia, with notes on little known species. *Internat. Rev. Hydrobiol. 83*: 439-448.

SEGERS, H., C.S. NWADIARO & H.J. DUMONT (1993): Rotifera of some lakes in the floodplain of the river Niger (Imo State, Nigeria). II. Faunal composition and diversity. *Hydrobiologia 250*: 63-71.

SERAFIM, M. JR. (1997): Heteroheneidade espacia e temporal da comunidade zooplanktônica do sistema rio Ivinhema-lagoa dos Patos, Planície de inundacão do alto rio Paraná (MS). Dissertation, State University of Maringná, Maringná. Paraná.

SHARMA, B.K. (1978): Contributions to the rotifer fauna of West Bengal. Part I. Family Lecanidae. *Hydrobiologia 57*: 143-153.

SHARMA, B.K. (1998): Faunal Diversity in India: Rotifera. Pp. 57-70. *In*: Faunal Diversity in India. (Eds: Alfred, J.R.B., A.K. Das & A.K. Sanyal). ENVIS Centre, Zoological Survey of India, Calcutta.

SHARMA, B.K. (2000a): Synecology of Rotifers in a tropical floodplain lake of Upper Assam (N.E. India). *Indian J. Anim. Sciences 70*: 880-885.

SHARMA, B.K. (2000b): Rotifers from some tropical flood-plain lakes of Assam (NE India). *Tropical Ecology 41(2)*: 175-181.

SHARMA, B.K. (2005): Rotifer communities of floodplain lakes of the Brahmaputra basin of lower Assam (N.E. India): biodiversity, distribution and ecology. *Hydrobiologia 533*: 209-221.

SHARMA, B.K. & V.K. DUDANI (1992): Rotifers from some tropical ponds in Bihar: species composition, similarities and trophic indicators. *J. Indian Inst. Sciences 72*: 121-130.

SHARMA, B.K. & MD. HUSSAIN (1999): Temporal variations in abiotic factors of a tropical flood plain lake, Upper Assam (NE India). *Rec. zool. Surv. India 97*: 145-150.

SHARMA, B.K. & SUMITA SHARMA (1999): Freshwater Rotifers (Rotifera: Eurotatoria). *In*: Fauna of Meghalaya. State Fauna Series *4(9)*: 11-161. Zoological Survey of India, Calcutta.

SHARMA, B.K. & SUMITA SHARMA (2000): Freshwater Rotifers (Rotifera: Eurotatoria). *In*: Fauna of Tripura: State Fauna Series *7(4)*: 163-224. Zoological Survey of India, Calcutta.

SHARMA, B.K. & SUMITA SHARMA (2001): Biodiversity of Rotifera in some tropical floodplain lakes of the Brahmaputra river basin, Assam (NE India). *Hydrobiologia 446 / 447*: 305-313.

SHIEL, R.J., J.D. GREEN & D.L. NIELSEN (1998): Floodplain biodiversity: why are there so many species? *Hydrobiologia 387 / 388*: 39-46.

SLADECEK, V. (1983): Rotifera as indicators of water quality. *Hydrobiologia 100*: 169-201.

TALLING, J.F. & I.B. TALLING (1965): The chemical composition of African lake waters. *Int. Rev. ges. Hydrobiol. 50*: 421-463.

■ ■ ■